IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YOUNG-HO CHO

Serial No.:	09/382,681	Examiner:	*to be assigned*
Filed:	25 August 1999	Art Unit:	2742
For:	SUBSCRIBER LINE INTERFACE CIRCUIT OF EXCHANGE SYSTEM		

TRANSMITTAL OF
ENGLISH TRANSLATION OF PRIORITY DOCUMENT

Assistant Commissioner
    for Patents
Washington, D.C. 20231

Sir:

    This transmittal accompanies a certified English translation of the Korean priority document No. 34480/1998 for the above-captioned application. The specification filed on 25 August 1999 in the above-captioned application **does not** conform to the invention of this application. Accordingly, the Commissioner is respectfully requested to disregard the specification originally filed on 25 August 1999 and conduct the examination under 37 C.F.R. §1.52(d) on the enclosed English language translation. The fee of $130.00 incurred under 37 C.F.R. §1.17(k) by the filing of the application in a language other than English accompanies this letter. The accompanying English language specification is an accurate translation of the Korean priority document No. 34480/1998.

Respectfully submitted,

[signature]
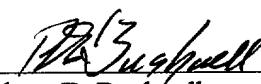
Robert E. Bushnell,
Attorney for the Applicant
Registration No.: 27,774

Suite 300, 1522 "K" Street, N.W.
Washington, D.C. 20005
(202) 638-5740

Folio: P55792
Date: 11/24/99
I.D.: REB/kf

34480/1998

DECLARATION FOR TRANSLATION

As a below named translator, I hereby declare that:

My residence and citizenship are as stated below next to my name.

I hereby certify that I am conversant with both the English and Korean language and the enclosed herewith is a true and accurate English translation of the Korea patent application document Serial No. 34480/1998.

FULL NAME OF TRANSLATOR: SeungMan KIM,

TRANSLATOR'S SIGNATURE: _____

Date: 23 November 1999

RESIDENCE: Robert E. Bushnell & Law Firm

1522 K Street, Suite 300, N.W., Washington D.C. 20005
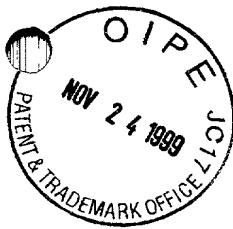
SUBSCRIBER LINE INTERFACE CIRCUIT OF EXCHANGE SYSTEM

[ABSTRACT OF THE DISCLOSURE]

[Abstract]

The present invention relates to a subscriber matching circuit for matching transmitted and received data so as to permit call communications between the exchanger and subscribers.

An analog subscriber matching circuit in an electronic exchanger matches transmitted/received data to permit call communications between the exchanger and subscribers by installing a hybrid subscriber matching circuit having individual parts without using a conventional transformer or SLIC for simplifying peripheral parts thereof as well as strongly resist an external impact or shock.

[Representative Drawing]

Fig. 1

[SPECIFICATION]

[title of the invention]

Subscriber line interface circuit in electronic exchanger system

[Brief Description of the Invention]

FIG. 1 is a schematic circuit diagram of the hybrid subscriber matching

circuit according to a preferred embodiment of the present invention.

FIG. 2 is a schematic circuit diagram of the DC bias equivalent circuit according to a preferred embodiment of the present invention.

[Detail Description of the Invention]

[Objects of the Invention]

[Field of the Invention and Background of the Invention]

The present invention relates to a subscriber matching circuit for an electronic exchange. In particular, the present invention relates to a subscriber matching circuit for an electronic exchange which matches transmitted/received data so as to permit call communications between the exchange and subscribers.

Generally, in an electronic exchanger, a subscriber matching circuit for matching with subscribers requires the functions of line current supply, supervision of a subscriber's state, call signal supply (ring signal supply) and detection, 2-line/4-line conversion, etc. The line current supply function serves to supply current for operating a subscriber's telephone and to supervise the on-hook/off-hook state of the telephone by detecting the variation of the supplied current. The line current supply function, which is performed with a function of limiting a maximum line current, serves to prevent unnecessary power consumption due to an oversupply of the line current to a short-distance subscriber. The 2-line/4-line conversion function serves to convert a 4-line signal transmitted from the telephone exchange or through transmission lines into a 2-line signal, while converting the 2-line signal transmitted from the subscriber's telephone into the 4-line signal.

1   Such an analog type subscriber matching circuit may employ a conventional

2 transformer. However, it cannot be adapted to the present-day trend of the high-

3 density integration and miniaturization due to its large size and magnetic saturation

4 caused by the line current. In order to adapt the trend of the high-density integration

5 and miniaturization, the subscriber matching circuit has been integrated into an

6 SLIC integrated circuit (IC). A subscriber matching circuit using the SLIC IC is

7 disclosed in Korean Patent Application No. 1994-40809 filed by the applicant of the

8 present invention. According to the subscriber matching circuit disclosed in Korean

9 Patent Application No. 1994-40809, however, all circuit elements are integrated

10 onto one chip, and thus it is relatively vulnerable to external impacts such as

11 lightning strikes in comparison to the circuit employing the transformer. As a result,

12 it requires a protection device as well as many peripheral parts thereof for

13 performing the subscriber matching function, thereby increasing the possibility of

14 experiencing difficulties in operation.

15 **[Technical objects for supporting the present invention]**

16   It is an object of the present invention to solve the problems involved in the

17 related art, and to provide a hybrid subscriber matching circuit for an electronic

18 telephone exchanger which can simplify the peripheral parts thereof and strongly

19 resist an external impact or shock.

20 **[Structure and Operation of the invention]**

21   The embodiment of the present invention is described in detail hereinafter

1   with the accompanying drawings.

2   FIG. 1 shows an embodiment of the hybrid subscriber matching circuit

3   according to the principle of the present invention.

4   The hybrid subscriber matching circuit for a full electronic exchanger

5   according to the principle of the present invention includes transistors Q1 and Q2

6   supplying a line current to a subscriber through a tip terminal and a ring terminal,

7   transistors Q3 and Q4 having a Darlington structure connected to the transistors Q1

8   and Q2 respectively and limiting a maximum current, current supervising resistors

9   R1 and R2 connected to emitters of the transistors Q1 and Q2 respectively and

10   performing a current feedback operation to limit the maximum current and detecting

11   a voltage form of a line current flowing through telephone lines, a resistors R3

12   connected between a collector of the transistor Q1 and a collector of the transistor

13   Q3 and preventing the transistors Q1 from being saturated, a resistor R4 connected

14   between a collector of the transistor Q2 and a collector of the transistor Q4 and

15   preventing the transistors Q2 from being saturated, three bias resistors R5, R6 and

16   R7 determining a threshold value of the maximum current and allowing the

17   transistors Q1 and Q2 to be in an active state, diodes D1 and D2 preventing the

18   transistors from being overheated due to a variation of the threshold value of the

19   maximum current and the heat generated by the line current (I_L), bypass capacitors

20   C1, C2, C3 and C4 preventing a bad influence on call communications due to the

21   generation or induction of noise introduced in the DC line current supply, capacitors

22   C5 and C6 superimposing a received audio signal (i.e., an AC signal) on the DC line

23   current, composite impedances ZL1 and ZL2 matching line characteristic

Page 4 of 14

1   impedance, amplifiers AMP1 and AMP2 receiving and amplifying the audio signal,

2   protection elements CR1 and CR2 protecting the amplifiers AMP1 and AMP2 from

3   being an over current state through lines, a resistor R11 converting the line current

4   flowing through the resistor R1 into an input current for detecting an off-hook state,

5   an operational amplifier AMP3 inversion-amplifying a signal inputted through the

6   resistor R11, a resistor R13 determining an amplification factor of the signal

7   inputted through the resistor R11, a transistor Q6 converting a level of the signal

8   inversion-amplified by the operational amplifier AMP3, a resistor R10 detecting a

9   ring trip voltage if a telephone handset is hooked off during supply of a call signal,

10 a resistor R12 converting the voltage detected by the resistor R10 into a ring trip

11 current, a capacitor C7 allowing the operational amplifier AMP3 to serve as a low-

12 pass filter so that an AC amplification factor is greatly lowered to remove AC ripple

13 components included in the ring trip current, and a field effect transistor FET1

14 allowing the operational amplifier AMP3 to serve as a low-pass filter in a ring

15 current supply state.

16   FIG. 2 shows the DC bias equivalent circuit according to the principle of the

17 present invention.

18   The operation of the embodiment of the present invention is now explained

19 in detail with reference to FIGS. 1 and 2.

20   The transistors Q1 and Q2 are to supply the current, and the transistors Q3

21 and Q4 are to limit the maximum current. The equivalent circuit of FIG. 2 performs

22 the line current supplying function. Since the circuit for supplying the line current

can be used for both a tip terminal and a ring terminal which have the symmetrical

arrangement in this embodiment, FIG.2 illustrates only the equivalent circuit for the

line current supply on the tip terminal side. Referring to FIG. 2, the line current (I_L)

becomes Ib1*$h_{FE.}$

The resistors R5 and R6 form a bias current Ib2 of the transistor Q2, which

is given by the following mathematical expression 1.

[Expression 1]

$$Ib2 = \frac{(V1 - V_{BE1} - V_{BE3})}{(Rb + R1)}$$

$$V1 = (\frac{Vbat}{2} - 2V_D) \times \frac{R5}{(\frac{R6}{2} + R5)}$$

$$Rb = R5 // \frac{R6}{2}$$

The line current (I_L) increases if the resistor R_L of the speech line decreases,

and as the line current (I_L) increases, the terminal voltage V_{R1} of the resistor R1 also

increases. If the voltage V_{R1} decreases due to the current feedback which decreases

the base current Ib1 of the transistor Q1 and the decrease of the resistance of the

resistor R_L of the speech line, the collector voltage V_{CE1} of the transistor Q1

increases. The increase of the collector voltage V_{CE1} of the transistor Q1 causes the

Page 6 of 14

1   increase of the current Ib1 through the resistor R3. The bias stability is improved by

2   the voltage feedback which decreases the collector voltage V_{CE1} of the transistor Q1.

3   Another important role of the resistor R3 is to prevent the saturation of the transistor

4   Q1. Specifically, if the resistor R_L of the speech line increases, the line current (I_L)

5   and the collector voltage V_{CE1} of the transistor Q1 decrease. The decrease of the line

6   current (I_L) causes the decrease of the amount of the current feedback through the

7   resistor R1. The continuous increase of the resistor R_L of the speech line causes the

8   continuous decrease of the line current (I_L) and results in that the collector voltage

9   V_{CE1} of the transistor Q1 extremely decreases to reach the saturation region of the

10   transistor Q1. At this time, the base current Ib1 of the transistor Q1 which is

11   supplied through the resistor R3 decreases due to the decrease of the collector

12   voltage V_C of the transistor Q1, and thus the saturation of the transistor Q1 is

13   prevented. Actually, this prevents the distortion of the AC characteristic in a long

14   loop in which the line resistor RL increases.

15   Also, the maximum current limitation is effected by the current feedback

16   through the resistor R1. The increase of the line current I_L causes the increase of the

17   terminal voltage $V_{R1,}$ and the current limitation is performed when the line current

18   (I_L) reaches a value corresponding to the state that the voltage of $V_R1+V_{BE}1+V_{BE}2$

19   becomes equal to the voltage of V1. However, if the current limitation is actually

20   generated due to the current increase, V_{CE} of the transistor Q1 increases, and this

21   causes the power consumption as much as I_L1*V_{CE} to be generated in the transistor

22   Q1, resulting in heat generation in the transistor Q1. Since V_{BE} is in negative

proportion to the temperature (that is, -2.4mV/°C), V_{BE} decreases as the temperature

increases, and this causes the current limitation value increases. An undesirable

repetition of such operations results in an error in the limited current. As a result,

the maximum current, much higher than the limited current actually required, flows.

In order to prevent this overheating phenomenon, the diode D1 which has a forward

voltage-temperature characteristic is connected between the base of the transistor

Q2 and the ground. In this case, since the forward voltage of the diode decreases to

the same level as V_{BE} of the transistors Q1 and Q2 due to the heat generated in the

transistor Q1, the variation of the limited current to the temperature is offset, and

thus the limited current can be more stably determined. Though the transistors Q1

and Q2 are connected in a Darlington structure, the base current Ib1 of the transistor

Q1 is actually limited by the resistor R3. The purpose of this construction is not to

improve the voltage gain by supplying an input signal to the base of the transistor

Q2, but to improve the gain of the current feedback performed by the resistor R1.

In other words, when the resistor R_L of the line varies within the range of the limited

current, the limited current is kept constant with respect to the variation of R_L of the

line by the transistors Q1 and Q2.

Meanwhile, the line current supervising function serves to convert the line

current into a logic signal by driving the transistor Q6 with an inversion-amplified

output of the voltage variation of the resistor R1. The line current supervising circuit

of FIG. 1 also performs the ring trip function simultaneously. Specifically, if the line

current (I_L) increases, the voltage drop is generated by the resistor R1, and this

voltage drop is inversion-amplified with the gain determined by the resistors R11

1 and R13 to drive the transistor Q6. If the transistor Q6 is driven, a logic "0" (low)

2 signal is outputted from the collector of the transistor Q6 to a detection terminal

3 DET. At this time, the line current (I_L) corresponding to the condition that the

4 detection terminal DET is in the logic "0" state is determined by the resistors R11

5 and R12. The line current supervising circuit also supervises whether the handset

6 is hooked off if the ring current is supplied during the supervision of the line current

7 (I_L). Specifically, a ring relay K1 is switched to the resistor R10, and the ring current

8 supplied from the ring terminal is applied to the tip terminal via the line resistor R_L

9 and the terminal telephone. In the off-hook state, the line resistor R_L including the

10 DC resistance of the terminal telephone decreases abruptly, and this causes the

11 voltage drop formed between the terminals of the resistor R10 to increase. This

12 dropped voltage is applied to the inverting terminal of the operational amplifier

13 AMP3 through the resistor R12 to be inversion-amplified. Accordingly, the output

14 signal of the operational amplifier AMP3 becomes high, and is applied to the base

15 of the transistor Q6 to turn on the transistor Q6, so that a low level signal is

16 outputted to the detection terminal DET to indicate the off-hook state of the

17 telephone. When the voltage drop of the resistor R10 increases, the signal inputted

18 to the inverting terminal of the operational amplifier AMP3 for inversion-

19 amplifying the terminal voltage of the resistor R10 becomes the DC signal

20 superimposed with the AC ring signal, and thus it is required to greatly reduce the

21 gain of the inversion amplifier AMP with respect to the AC signal in order to detect

22 the DC signal only. The reduction of the AC gain in the operational amplifier AMP3

23 invites the reduction of the AC gain by the capacitor C7 connected in parallel to the

1 resistor R13, and thus the DC signal with its ripple component greatly suppressed

2 is outputted from the operational amplifier AMP3, enabling the ring trip operation

3 to be performed accurately. The field effect transistor FET1 is turned on only when

4 the ring relay K1 operates, and thus has no effect on the line current supervising

5 function in a normal state. At this time, since the capacitance of the capacitor C7

6 cannot be selected as an infinite value, the resistors R11, R12 and R13 should have

7 a large resistance value in the range of several hundred kilo-ohms (KΩ) in order for

8 the capacitor C7 having a small capacitance value to act as a low-pass filter.

9 **[effects of the invention]**

10 As described above, the subscriber matching circuit according to the present

11 invention is designed to use general parts while it performs the same function as the

12 conventional analog subscriber matching circuit using a transformer or SLIC, and

13 thus the manufacturing cost thereof can be greatly reduced. Further, the subscriber

14 matching circuit according to the present invention has an on-hook transmission

15 function, and thus can be applied to additional services such as remote charging,

16 transmission of a calling subscriber's number, etc.

WHAT IS CLAIMED IS:

1. An analog subscriber matching circuit for a full electronic exchange comprising:

a first pair of transistors (Q1, Q2) supplying a line current to a subscriber through a tip terminal and a ring terminal;

a second pair of transistors (Q3, Q4) having a Darlington structure and connected to said first and second transistors (Q1, Q2) respectively, and limiting a maximum current;

a first pair of current supervising resistors (R1, R2) connected to emitters of said first pair of transistors (Q1, Q2) respectively, performing a current feedback operation to limit said maximum current, and detecting in a voltage form a line current flowing through telephone lines;

a first resistor (R3) connected between a collector of one of said first pair of transistors (Q1) and a collector of one of said second transistor (Q3), preventing one of said first pair of transistors (Q1) from being saturated;

a second resistor (R4) connected between a collector of the other one of said second transistors (Q2) and a collector of the other one of said second pair of transistors (Q4), preventing said transistor (Q2) from being saturated;

a group of bias resistors (R5, R6, R7) determining a threshold value of said maximum current and maintaining said first pair of transistors (Q1, Q2) in an active state;

a first pair of capacitors (C5, C6) superimposing a received AC audio signal

22   on a DC line current;

23   a pair of composite impedances (ZL1, ZL2) matching a line characteristic

24   impedance;

25   a third resistor (R11) converting said line current flowing through one of the

26   current supervising resistors (R1) into an input current for detecting an off-hook

27   state;

28   an operational amplifier (AMP3) inversion-amplifying a signal inputted

29   through said third resistor (R11); and

30   a fourth transistor (Q6) converting a level of a signal inversion-amplified by

31   said operational amplifier.

1   2. The analog subscriber matching circuit of claim 1, further comprising a

2   pair of amplifiers (AMP1, AMP2) connected to said composite impedances (ZL1,

3   ZL2), respectively, for receiving and amplifying the audio signal.

1   3. The analog subscriber matching circuit of claim 2, further comprising a

2   pair of protection elements (CR1, CR2) for protecting said amplifiers for amplifying

3   said audio signal from an over current through lines.

1   4. The analog subscriber matching circuit of claim 3, further comprising a

2   dummy load resistor (R8) connected between the collector of one of said first pair

3   of transistors (Q1) and the collector of the other one of said first pair of transistors

4   (Q2) for supplying a bias current to said first pair of transistors (Q1, Q2) to prevent

5 said first pair of transistors (Q1, Q2)from being saturated when no load exists on

6 said line.

1 5. The analog subscriber matching circuit of claim 4, further comprising a

2 pair of temperature compensating diodes (D1, D2) connected to opposite sides of

3 said bias resistor group (R5, R6), respectively, for preventing said first pair of

4 transistors (Q1, Q2) from being overheated due to a variation of the threshold value

5 of said maximum current caused by the heat generated from said first pair of

6 transistors (Q1, Q2) due to the line current.

1 6. The analog subscriber matching circuit of claim 5, further comprising a

2 plurality of bypass capacitors (C1, C2, C3) preventing a bad influence on call

3 communications due to the generation or induction of noise in said DC line current

4 supply.

1 7. The analog subscriber matching circuit of claim 6, further comprising a

2 fifth resistor (R13) determining an amplification factor of said signal inputted

3 through said third resistor (R11).

1 8. The analog subscriber matching circuit of claim 7, further comprising a

2 sixth resistor (R10) detecting a ring trip voltage if a telephone handset is hooked off

3 during supply of a call signal.

9. The analog subscriber matching circuit of claim 8, further comprising a seventh resistor (R12) converting the voltage detected by said sixth resistor (R10) into a ring trip current.

10. The analog subscriber matching circuit of claim 9, further comprising a second capacitor (C7) allowing said operational amplifier (AMP3) to serve as a low-pass filter so that an AC amplification factor is greatly lowered to remove AC ripple components included in said ring trip current.

11. The analog subscriber matching circuit of claim 10, further comprising a field effect transistor (FET1) allowing said operational amplifier (AMP3) to serve as a low-pass filter in a ring current supply state.